Organization Science
Vol. 18, No. 5, September–October 2007, pp. 813–831
ISSN 1047-7039 | EISSN 1526-5455 | 07 | 1805 | 0813
DOI 10.1287/orsc.1070.0284

Activating the Informational Capabilities of Information Technology for Organizational Change

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This paper considers how the information enabled by information technology (IT) is implicated in organizational action. It begins by proposing that the relationship between technology appropriations and an organization's informal advice networks is one useful way to understand how the information that is created, modified, transmitted, and stored through the use of IT can lead to organizational change. I then present the findings of an ethnographic study of the implementation and use of a new information technology service management (ITSM) tool in a large IT organization. The findings show that a number of discrepant events led technicians to appropriate the material features of the technology in certain ways, thus providing them with new and different kinds of information than was available to them previously. Armed with such information, technicians began to seek advice differently than they had before, which led to an overall transformation in the organization's social structure. I characterize appropriations of a technology's features as a set of practices that *activate* the informational capabilities of a new technology through advice networks. In activating its informational capabilities, technicians transformed the potential that the technology had to create, modify, transmit, and store information in new ways into resources used to organize their work. I conclude by discussing the implications of the findings for theorizing about and management of technologically induced organizational change.

Key words: technology implementation; organizational change; information; social construction

One quality of ITs that differentiates them from many other types of technologies studied by organizational researchers is that they carry with them new possibilities for the creation, modification, transmission, and storage of *information*. Lucas (1975), Rice (1987), Zuboff (1988), and other early researchers of IT use showed that these new artifacts could provide information that was previously unavailable or inaccessible to organizational members. These studies demonstrated that the introduction of an IT into an established organizational context required individuals to learn not only to cope with the artifact's material features, but also to deal with the new ways in which that artifact handled information. What distinguishes ITs from process technologies (such as those written about by contingency theorists) and mechanical manufacturing technologies (such as those written about by strategic choice theorists) is that they can and do provide new affordances for and constraints on the way information is used within organizations.

In recent years, there has been a growing interest in exploring how and why individuals interact with an IT's material features—those hardware and software components that make them recognizable as "technological artifacts" (DeSanctis and Poole 1994, Orlikowski 2000, Robey and Sahay 1996) as well as in the symbolic value of using those features (Boczkowski 2004, Kaarst-Brown and Robey 1999, Vaast and Walsham 2005). A less explored aspect of IT's role in organizational change centers on the informational capabilities enabled by the new technology. Reviews of the literature on IT and organizational change show that most extant studies have treated ITs in much the same way as conventional production or mechanical technologies, drawing explicit comparisons between them in theory building (e.g., Rice and Gattiker 2001). The shortcoming of such an approach is that the role information plays in organizational change is often undertheorized and ITs are treated as if they were just technologies, receiving no special attention.

This paper explores how the information that a new IT enables—that primary characteristic that distinguishes ITs from other more conventional artifacts—can lead to changes in the social structure of an organization. Specifically, I propose that one way to understand how the informational capabilities of an IT—the potential a technology has for creating, modifying, transmitting, and storing information in new ways—can lead to organizational change is by exploring the informal advice networks that constitute an organization's social structure. The findings of an ethnographic study of the implementation and use of an ITSM tool in a large IT organization show that a number of discrepant events led to new uses of the ITSM, and these new uses led technicians to mobilize the information in the tool in different ways. As new and different kinds of information became available to users, they began to seek advice differently than they had before, which led to an overall transformation in the organization's social structure. I conclude

with a discussion of how the informational capabilities of ITs can lead to organizational change, and I consider the implications of these findings for theory about and management of new IT implementations.

Theoretical Background

Information and Social Structure

Researchers who focus on the instrumental and symbolic properties of information have shown that information often plays a key role in defining the contours of an organization's social structure. Many early contingency theorists recognized the important role of information in determining organizational form. Authors such as Thompson (1967), Galbraith (1973), and Tushman and Nadler (1978) all viewed the organization as an information-processing entity and argued that the most appropriate form for an organization's social structure was the one that most closely matched its information-processing requirements.

More recent research has sought to explain how information affects the patterns of interaction through which organizing is accomplished. This research has shown that an organization's informal social structure is often altered as information is manipulated or new information becomes available for organizational members. Feldman and March (1981), for example, argued that individuals in organizations often acquire information (even if it serves no immediate purpose) to signal to others that they have knowledge about certain processes. When there is no reliable alternative for assessing a decision maker's knowledge, visible aspects of information gathering and storage practices are used as implicit measures of one's ability to make an informed decision. The implication is that certain individuals come to have more power in the decision-making process due to the perceptions of their information-acquiring practices. Other studies have shown that when organizational members possess information that is not shared, they are often deferred to in decision-making situations and tend to acquire more power than those who lack information that is deemed necessary and important (e.g., Deetz and Mumby 1985).

Apart from the ways in which information can affect one's personal standing in an organization, researchers have shown that the practices of dealing with new information can lead to changes in the way individuals interact. Research in social psychology consistently shows that group members often revise and reformulate their roles to respond to and act on the new information available to them. Stasser and Titus (1985) found that group members who possessed information that was not known by others often withheld that information in decision-making situations. In many cases, this biased information sharing resulted in uninformed decisions in the group context and elevated the status of individuals who did share information. Similarly, Levine and Moreland (1998) showed that status and position in a group are often influenced by the quality and quantity of information possessed by its members. When information is distributed equally among members of a group, individuals often experience a reduction in level of overall communication in the group, equalization of participation rates among members, and weakening of the group power status system.

Information is a valuable commodity in organizations because the possession or absence of it can alter social structure by positioning those who have information as powerful actors, and those who do not as less powerful. Daft and Weick (1984) suggest that the practice of acquiring information is an important antecedent to organizational change because organizations must routinely collect or scan for information to make the decisions that will either directly or inadvertently initiate social structural changes.

Social Structure and Advice Networks

Because information is closely linked to an organization's social structure, it is important to consider how information is implicated in organizational change. Over the years, numerous scholars have eschewed static, abstract notions of social structure in favor of a dynamic and interactional stance, which holds that the process of organizing is ongoing and always in flux. Such a view takes as a starting point the belief that an organization's social structure is accomplished through communication and interaction among members (Giddens 1984, Goffman 1983). Such arguments, however, do not normally specify what types of communication and interaction structures researchers should observe if they wish to capture the process of organizing in action. Yet early work points in the direction of an answer. For example, Rothlisberger and Dickson's (1939) famous "wiring" diagrams from their studies of Western Electric's Hawthorne plant depict a set of relationships based on patterns of advice seeking. The authors suggested that even though the formal structure of the organization was quite specific about who should ask whom for help on a problem, organizational members regularly constructed their own advice networks based on certain endogenous factors, such as who sat next to whom and who participated in what games. Similarly, Blau (1955) studied agents in a federal department who were not allowed to consult colleagues about special cases, only supervisors. Through informal practices of advice seeking and consultation, however, communication structures were instantiated that gave rise to a system where more experienced agents regularly told stories about "strange cases," and newer agents would troubleshoot them to learn. More recent studies adopting a network analytic approach have suggested that advice networks (or patterns of advice seeking) are one important way

to capture the informal properties of organizing, and those most implicated in organizational change programs (Gibbons 2004, Krackhardt 1992).

Information is clearly bound up with the practice of advice seeking in organizations. Individuals regularly seek advice because they wish to obtain important and necessary information from others (Haythornthwaite and Wellman 1998), and individuals are often sought for advice when others perceive that they have relevant information (Rice et al. 1999). Thus, from a dynamic and interactional perspective on the process of organizing, information sharing via advice networks is a constitutive property of social structures. Although most researchers have examined the informal (i.e., emergent, unsanctioned) networks of advice within organizations, formal social structures such as those depicted in the organization's hierarchical chart depict idealized forms of information possession and transmission. As Nadel (1957) suggested some 50 years ago, organizations create formal roles that depict what positions should act as the gatekeepers of certain kinds of information. Therefore, information becomes one key aspect that distinguishes one role or position from another. Advice networks thus mark an interesting case because indications of who should ask whom for advice are often stringently specified in the organization chart. Part of the reason for making such delineations is that there is a tremendous amount of status associated with being the recipient of requests for advice (Blau 1955, Gould 2002). Higher status within an organization's social structure is conferred on those who receive requests for advice more often than they request it.

If the study of advice networks is one way of capturing the social structural properties of organizing, researchers can also document organizational change by examining the ways that the status and/or influence of individual actors or groups of actors is instantiated and reconfigured through the exchange of information. Although status is often theoretically delineated in an organization's formal chart, Gould (2002) suggests that, in practice, status is an inherently emergent phenomenon. He argues that because status is linked to advice seeking (i.e., who has certain/important information), status and power in a social structure can easily be changed as actors reproduce or change status hierarchies by adjusting their own advice-seeking practices. In other words, even in the presence of a formal structure, status can change depending on symmetry in attachments. If one has more *in-ties* (requests for advice) than *out-ties* (requesting advice from others), this asymmetry creates a position of status. Thus, researchers can obtain a snapshot of an organization's social structure at one point and document how it changes over time by observing what actors or groups of actors give advice more often than they receive it. Advice networks mark one way that those status-related positions defined by information flows in the organizational chart can become inconsistent with the social structure created and perpetuated daily by the interactions of organizational members.

Advice Seeking and Information Technology Use

An increasing number of studies demonstrate that the introduction of a new technology into a formal organization may serve as a catalyst for the formation of new advice networks (Aydin and Rice 1992, Barley 1990a, Burkhardt and Brass 1990, Rice et al. 1999). A new IT can bring about changes in the informal properties of organizing even if it does not change the organization's formal chart (Fulk 1993, Orlikowski 1996, Robey and Sahay 1996). Whereas culture and work practices are relatively stable forces within an organization (i.e., they do not change frequently or rapidly), a new IT is more of a punctuating force. That is, an IT can disrupt an established social structure and lead to new patterns of advice seeking because it provides new informational capabilities.

Although research on technology and advice networks is sparse, extant studies do offer a number of insights as to why advice networks, and by implication an organization's social structure, might change in response to a newly implemented IT. Barley (1990a) showed that changes in consultation patterns between radiologists and technicians in two hospitals following the implementation of a computed tomography (CT) scanner could be linked to one's familiarity with the scanner's operation. Radiological technicians, who were more skilled at running the scanner than the hierarchically superior radiologists, often fielded radiologists' questions about how to position a patient or read films. Burkhardt and Brass (1990) found similar results in their study of the introduction of a computer system in a federal agency responsible for the analysis and dissemination of a national database of nutrition data. Early adopters of the computer system increased their power and centrality in the organization to a greater degree than late adopters by sharing information about the system's functioning with those who were less familiar. Aydin and Rice (1992) studied the implementation of an integrated medical information system in a large university's medical center. Their findings showed that the degree to which a user received information from systems personnel and trainers about how to use the new technology was more important than either general participation or computer use itself in predicting increases in patterns of consultation among departments.

Together, these studies demonstrate that changes in advice networks can be tied directly to the knowledge an individual has about the newly implemented IT. Early adopters/users learn about the functionality of the system and can then communicate that information to their coworkers.

Although these studies, and others like them, discuss how advice networks change in response to one's information about the new IT, they do not show how the information created, modified, transmitted, and stored through the IT itself can lead to changes in the social structure of an organization via its advice networks. To empirically demonstrate this phenomenon, researchers must provide verifiable examples of how individuals actually use the material features of the new IT.

Poole and DeSanctis (1990) were among the first researchers to apply the concept of "appropriation" to studies of technology use as a way of highlighting the important role that one's actual engagement with the material features of an artifact plays in the production of organizational outcomes. DeSanctis and Poole (1994, p. 131) suggest that appropriation of a technology's material features…

> …is evidenced as a group makes judgments about whether to use or not use certain structures, directly uses (reproduces) a [technology's] structure, relates or blends a [technology's] structure with another structure, or interprets the operation or meaning of a [technology] structure.

Appropriations are social, not material, although they do involve a group's negotiated stance toward a technology's material features. This is evidenced in DeSanctis and Poole's (1994, p. 135) detailed exposition of how various types of appropriation moves (varied uses of one technology) are made in response to a number of structural features characteristic of the organization. In this paper I adopt Poole and DeSanctis' use of the term "appropriation" to refer to the process of using the existing features of an IT in ways that align it with the demands of the social context in which it is embedded. Users do not have to use a technology in unintended or novel ways to appropriate it—they just have to use it. In this frame, the questions of *how* and *why* they use the features the way they do are of primary importance. An IT can be thought of as both a social and a material object because the impact of its material features is created and transformed through the social action of collective appropriation.

The most recent research on advice seeking and IT use has begun to move in the direction of linking the actual appropriations of a technology's features (what people do when confronted with the artifact's physical affordances and constraints) to changes in an organization's social structure (Rice et al. 1999, Sussman and Siegal 2003). However, these recent studies have typically focused on how individuals construct advice networks in the context of learning how to use the new IT, rather than focusing directly on how they construct those networks by using the information enabled by the IT. This latter view suggests that the ways that users appropriate the material features of the artifact will directly influence how they create, modify, transmit, and store the *information* that the IT enables. To understand how the informational capabilities of a new IT either sustain or change an organization's social structure via its advice networks, researchers must detail how that information is mobilized through the differential appropriations users make of the technology's features. To explore this process, I collected ethnographic data on the implementation of an IT service management tool into the routine work of computer technicians.

Background and Methods

The research setting for this study was the IT department at SkyLabs (a pseudonym), a large government-funded research center in the United States. IT department technicians used computing and networking technologies to support nearly 250 employees in seven different administrative divisions. In August of 2002, the IT department was reorganized from 10 project organizations into four functional organizations. In this study I focus on the changes that occurred in one of these newly formed functional organizations: network engineering and technical systems (NETS). None of the new NETS technicians had worked together before, and all were accustomed to working autonomously. Five were women and three were men; all were Caucasian and born in the United States. Their average age was 37. NETS technicians occupied one of three hierarchical levels in the organization—Class 1, Class 2, or Class 3 technician. Those who held the position of Class 1 technician were the most junior members, whereas the two Class 3 technicians had been with SkyLabs for more than 25 years.[1] Demographic data for NETS technicians are presented in Table 1.

NETS primary mission was to support the IT needs of the seven administrative divisions at SkyLabs. Their daily job activities were similar to the technicians studied by Orlikowski (1996) and Zabusky (1996). NETS technicians were responsible for all user-end and back-end software and hardware service and implementation throughout the divisions. At the user end, NETS technicians responded to help-desk calls for software and

Table 1 Demographic Information for NETS Technicians

Technician	Gender	Age*	Years at agency**	Job title
1	Female	62	26	Class 3 technician
2	Male	58	25	Class 3 technician
3	Female	46	18	Class 2 technician
4	Male	46	15	Class 2 technician
5	Female	41	12	Class 2 technician
6	Male	38	10	Class 1 technician
7	Female	36	9	Class 1 technician
8	Female	32	4	Class 1 technician

*Mean = 44.88, standard deviation = 10.5.
**Mean = 14.75, standard deviation = 7.6.

hardware problems. They made recommendations and approved all software and hardware purchases. They were also responsible for the selection, testing, modification, and implementation of organization-wide software suites such as MS Windows and its applications, data-sharing, and calendaring software.

My research with NETS extended from January–May 2003. In an attempt to ease some of the difficulties that NETS faced when coordinating work, the director of the IT department suggested that NETS implement an ITSM tool that was already being used by another functional organization. The ITSM was a help-desk queuing application with the ability to record the computing problems encountered in the administrative divisions, track the progress of these issues, and document the steps a technician took to solve them. All the NETS technicians were familiar with the system because they had seen it used in one of the other functional organizations, but none of them had used it prior to this study. The ITSM was implemented in February of 2003 and technicians began to use it right away. I was thus able to observe how technicians worked prior to the introduction of the new technology, the way they incorporated the ITSM into their daily work, and how these uses led to changes in the social structure of the NETS organization during the subsequent four months of this study.

Data Collection and Analysis

The data used in this study to understand the relationship between microsocial technology use and changes in social structure were collected through field observation, shadowing, and semistructured interviews. Field observation has been shown to be an effective method of data collection for studies of IT implementation because it allows the researcher to see and document the actual practices individuals use when interacting with a technology. From my first days at SkyLabs I began attending staff meetings, accompanying technicians when they went on site with a user, and observing work conducted in isolation from others. Observing this wide variety of activities provided useful context for understanding why certain changes arose, whereas others did not. I paid attention to the features of the social context that led technicians to use the ITSM in certain ways. I also actively sought to uncover contextual features that discouraged them from using the technology in other ways.

For an increased understanding of their work, I conducted formal observations by shadowing. Each of the eight NETS technicians was shadowed four times throughout the study, twice during a morning session, and twice during an afternoon session. I followed each technician for a half-day at set intervals. I sat with them when they used the ITSM, went with them when they responded to user issues, and when they returned to their offices to document the problems they encountered. I wrote down each activity as it occurred, the details of that activity, and the time it took to be completed.

The first round of shadowing was conducted at the beginning of January 2003, one month before the ITSM was implemented; the second round was conducted at the beginning of February, one to two weeks after the implementation; and the remaining two rounds were conducted at the beginning of March and April. This diachronic data collection procedure allowed me to capture events as they unfolded and to chart changes in technology use and in social structure over time (Barley 1990b). Coincidently, each of the four shadowing periods (with the exception of the first) occurred one or two weeks prior to the disjunctures that defined the four phases discussed below. This fortuity allowed for detailed observations of the work of NETS technicians in each of the four phases.

Finally, I collected data through semistructured interviews. Each technician was formally interviewed four times throughout the study, directly following each round of shadowing. Technicians were asked a series of open-ended questions comprising four categories: (1) reflections on the nature of their work, (2) reflections on the structure of the organization, (3) perceptions of their work in relationship to the success of NETS, and (4) the purpose and function of the new ITSM. To obtain an outsider's perspective on NETS' work, several times throughout the study I also conducted interviews with users in the various administrative divisions about their perception of technicians' work.

For this study an iterative approach to coding and analysis was adopted. Although initial themes were identified during data collection, systematic coding did not begin until data collection ended. Analyses began with identifying naturally occurring phases in the evolution of use of the ITSM. Identifying phases before appropriation moves or changes in structure avoided temporal distinctions based on knowledge of changes themselves.[2] I began by looking for events that were viewed by insiders as disjunctures from normal practice (what I later call discrepant events). In addition to the implementation of the ITSM, the organization's formal decision to use the new technology to centralize the assignment of jobs and a staff meeting in which technicians agreed to document the user problems they routinely encountered were viewed by NETS technicians as important disjunctures. Thus, informants' own experiences with their work suggested three breakpoints demarcating four observable phases during the course of the study.

For analysis of the appropriations NETS technicians made of the ITSM, I began by identifying microlevel actions that individuals took as they engaged with the new technology. Specifically, I paid attention to what features of the ITSM they used, what features they did not use, and why they chose to use them or not. DeSanctis and Poole (1994, p. 140) suggest that because the "meaning of action is critical to appropriation, strict coding schemes are less informative than more qualita-

tive interpretive schemes." Thus, to identify the ways in which NETS technicians appropriated the ITSM within each phase, I followed three stages of coding practices outlined by Strauss and Corbin (1998). In the first stage—open coding—I categorized data collected through observations, shadowing logs, and interviews into groupings of like concepts. After all of the data had been analyzed in this fashion, concepts were organized by recurring theme. In the second stage—axial coding—these themes were linked by constructing subcategories that regrouped the data into clusters of similar activities. Finally, in the third stage—selective coding—I integrated all analyses for each category into a set of core findings. This iteration between data and concepts ended when I reached theoretical saturation, i.e., enough categories had been identified to explain why certain appropriations were made. I scrutinized the validity of these findings by sharing them with the NETS organization, thus ensuring that I captured their emic experience of work with the ITSM.

After this analysis reached a point at which I could describe in detail the types of appropriations NETS technicians made of the ITSM within each phase and why they made them, I then returned to the raw data to confirm and explain the changes that resulted in the organization's advice networks, and hence its social structure. As Marsden (2005) notes, relatively few network studies of social structure have drawn on this type of microlevel observational data because it is so difficult to gather. The data collection methods in this study, however, provided a rich behavioral data set that demonstrated (1) specific technology appropriations in context, (2) the ways appropriations affected work practices, and (3) how stasis or change in work practices produced communicative exchanges among the technicians observed in this study. Accordingly, this behavioral data set permitted me to create technologically induced advice networks in each of the four phases and then to compare these networks over time. For each phase I created a permuted 8×8 adjacency matrix where technicians occupying similar formal roles (i.e., Class 1, 2, or 3) were contiguously arrayed. I then populated the matrices with a raw count of how many times each technician was asked for advice (in-ties) by one of the other technicians. Because technicians rarely ask others for help on routine problems (Zabusky 1996) and many technicians feel that there is a stigma associated with needing help from another (Orr 1996), the very act of asking for help was important in its own right. For this reason, the matrices were dichotomized by setting each cell equal to 1 ($\alpha \geq 1$) if a technician asked another for help more than one time in each of the four phases. The dichotomized matrices for these observed advice networks are displayed in Figure 1(a).

Figure 1 Observed and Ideal Advice Networks for NETS Technicians (Dichotomized at $\alpha \geq 1$)

(a) Image matrices of observed advice networks

Breakpoint 1 (discrepant event) → **Implementation of ITSM**

Breakpoint 2 (discrepant event) → **Decision to use ITSM for job assignment**

Breakpoint 3 (discrepant event) → **Decision to document solutions in ITSM**

Phase 0

	1	2	3	4	5	6	7	8
1	0	1	0	1	1	0	0	1
2	1	0	0	1	0	0	0	0
3	1	1	0	0	1	0	0	0
4	1	1	1	0	0	1	0	0
5	1	1	0	1	0	0	0	0
6	1	1	1	0	0	0	1	0
7	1	1	1	0	1	0	0	0
8	1	1	0	0	0	1	1	0

Phase 1

	1	2	3	4	5	6	7	8
1	0	1	1	0	1	0	0	0
2	1	0	0	1	0	0	0	0
3	1	1	0	1	0	0	1	0
4	1	1	0	0	1	1	0	0
5	1	1	1	0	0	0	0	0
6	1	1	1	1	0	0	0	1
7	0	1	1	1	0	1	0	0
8	1	1	1	1	0	0	1	0

Phase 2

	1	2	3	4	5	6	7	8
1	0	0	0	1	1	1	1	0
2	0	0	1	0	1	1	0	1
3	1	1	0	1	0	1	1	0
4	1	1	0	0	0	1	1	1
5	1	0	1	0	0	1	0	1
6	0	1	1	1	0	0	0	1
7	1	1	0	1	1	0	0	0
8	1	0	1	1	1	0	1	0

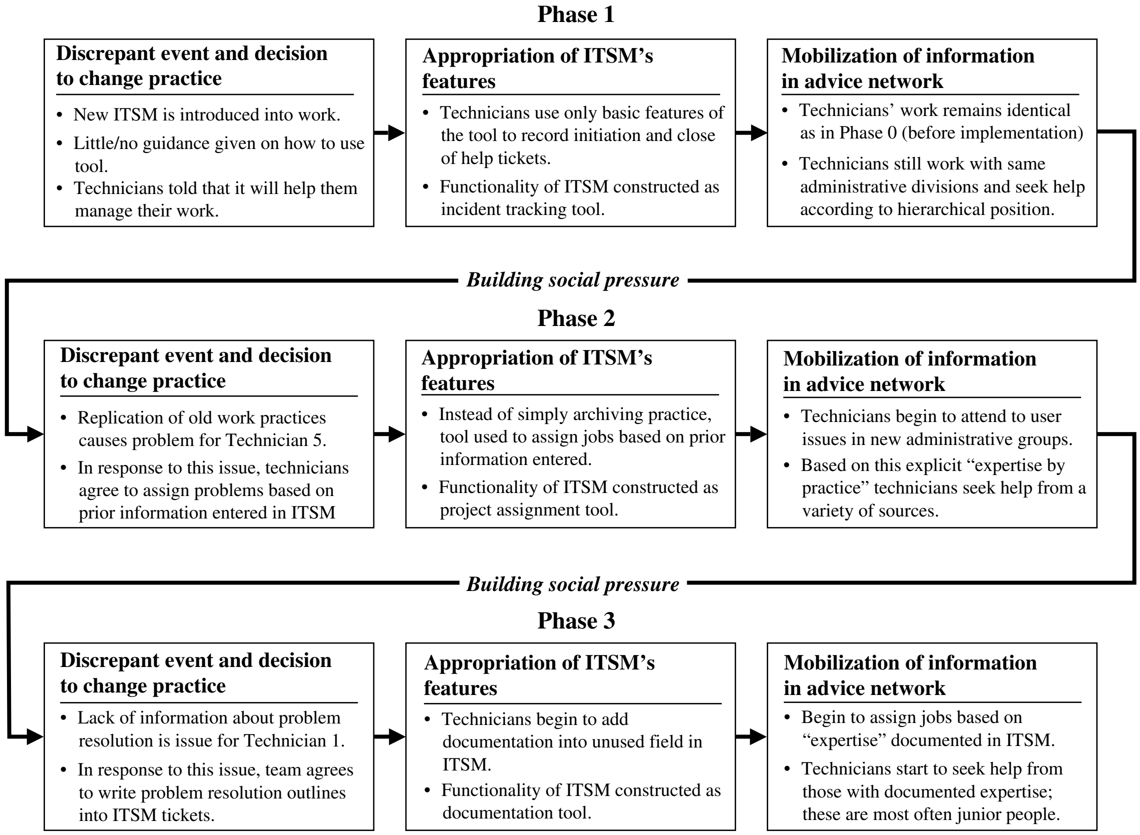
Phase 3

	1	2	3	4	5	6	7	8
1	0	0	0	0	1	1	1	1
2	0	0	1	0	0	1	1	1
3	0	0	0	1	1	1	1	1
4	0	1	0	0	1	1	1	1
5	0	0	0	0	0	1	0	1
6	0	0	1	0	1	0	1	1
7	0	0	0	1	0	1	0	1
8	1	1	0	1	1	0	0	0

(b) Image matrix of institutionally legitimate (ideal) advice network

	1	2	3	4	5	6	7	8
1	0	1	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0
3	1	1	0	1	1	0	0	0
4	1	1	1	0	1	0	0	0
5	1	1	1	1	0	0	0	0
6	1	1	1	1	1	0	1	1
7	1	1	1	1	1	1	0	1
8	1	1	1	1	1	1	1	0

Figure 2 Discrepant Events, Technology Appropriations, and Changes in Advice Seeking in NETS Organization



To compare whether the observed advice networks in each of the phases differed at all from the formal chain of command through which technicians "should" have asked for help, I also constructed an institutionally legitimate or "ideal" advice network. Figure 1(b) demonstrates how technicians would have sought advice if they followed the formal organizational chart.[3] The matrix displays both vertical (asking one's superiors) and horizontal (asking one's peers) advice-seeking behaviors. The different gradations in the matrix signal the formal hierarchical distinctions, with the darkest cells indicating Class 3 and the lightest indicating Class 1 technicians.

Several methods were used to analyze these data. First, I used the quadratic assignment procedure (QAP; Hubert and Schultz 1976) to determine whether changes in advice-seeking behavior occurred between each of the phases and if these behaviors differed significantly from the way technicians would have sought advice if they followed the formal organizational chart (an institutionally legitimate or ideal network). To provide details about how advice-seeking behaviors differed across phases, centrality scores (Freeman 1979) were calculated for each of the eight technicians. Degree centrality measures how active a particular actor is in the sense that they have the most ties to other actors in the network. A technician with a high degree of centralization is a key player (i.e., is asked for advice often) in the advice network. Finally, to understand whether technicians' roles and the relations between them changed in accordance with the centrality of particular actors (i.e., to verify that changes affected the whole organization, not just the status of any one technician) blockmodeling techniques (White et al. 1976) were used to determine how such changes occurred over time. The details of these network measures will be presented below.

Findings

The data analysis procedures outlined uncovered three interrelated processes through which the information enabled by the ITSM tool led to changes in the social structure of the NETS organization. These processes are outlined in Figure 2. First, the social pressures that fomented as technicians interacted with users and with each other in the course of their normal work produced discrepant events. Majchrzak and her colleagues (2000, p. 590) define a discrepant event as "an event that explicitly called into question an exiting structure." For the NETS organization, these discrepant events were those instances where technicians began to explicitly doubt the efficacy of their existing work practices, and in so doing make a conscious decision to change their interactions with the material features of the ITSM. Overall, the three discrepant events identified in this study demarcated four

phases of technology appropriation and, hence, formations of the social structure in the NETS organization. Second, discrepant events led to new appropriations of the ITSM. By deliberately deciding to change the way they used the IT, technicians began to make microlevel appropriations of its material features in new ways. In other words, they used various features of the IT to create, modify, transmit, and store information differently than they had in previous phases. Third, these new appropriations mobilized the information in the tool through the advice networks that constituted NETS' informal social structure. Although appropriations of the ITSM's features changed the type of information it enabled, that information was only transformed into a social force as it became a resource that technicians used to decide from whom to seek advice. In this sense, using information in the tool in different ways led technicians to form new patterns of interaction, which became constitutive features of the social structure of the NETS organization.

In the following sections I present the empirical findings of this study, beginning with a brief overview of the work practices of technicians before implementation of the ITSM (which I call "Phase 0"). This provides context for understanding why certain social pressures later arose among them. Next, I discuss how social pressures occasioned by team dynamics led to discrepant events that empirically marked the commencement of each phase of technology use during the five-month duration of this study. I then present evidence of the kinds of appropriations of the ITSM that resulted from these discrepant events. The final section details how the appropriations of the technology in each of the phases led to changes in NETS' advice networks.

Work Context Before Implementation of ITSM

Prior to the departmental reorganization, each technician worked in a separate project organization that serviced one of the seven administrative divisions.[4] From a structural standpoint, all technicians occupied similar work roles. They provided basic IT support for PC users in the administrative division in which they worked. When users called or e-mailed about a computing issue, technicians went to the user's desk to work on the problem. Because they were the sole member in their project organization responding to user problems, technicians were able to operate autonomously.

When the IT department was reorganized from 10 project organizations into four functional organizations in August 2002, all of the technicians who provided user support were structured into NETS. According to the IT manager, the goal of the reorganization was to provide higher-quality technical support to the administrative divisions. For NETS, this meant improving the speed and quality of customer problem resolution. The transition to the new functional structure meant that NETS technicians were no longer assigned to a particular administrative division. Instead, the NETS organization as a whole was now collectively responsible for user needs across all seven divisions.

By January 2003, NETS technicians had worked together just under six months. Yet the way they responded to user issues still mirrored the division of labor under the old project organization structure. Instead of responding across multiple divisions, individual NETS technicians continued to serve as the single point of contact for users in the particular administrative division for which they had worked. Because users submitted requests for help on technical issues through e-mails sent directly to a specific technician, NETS members were normally unaware of the issues with which their coworkers were dealing. Although the ways that technicians interacted with users did not change under the new functional structure, patterns of interaction among technicians themselves changed substantially. Under the project organization structure, technicians admitted that when they encountered a problem they did not know how to solve, their flow of work often came to a dramatic halt. Under the new functional organization structure, junior technicians began to seek advice on technical matters from more senior technicians. In the following example taken from field notes, Technician 7 (one of the most junior technicians) learns by seeking help from Technician 1 (the most senior technician) that a bug her user encountered in the calendaring software is common at SkyLabs:

> **Tech 7:** Hey, do you know anything about a bug in the calendaring software?
>
> **Tech 1:** Yeah, they were having some of those issues in Travel about a month ago.
>
> **Tech 7:** Really?
>
> **Tech 1:** Yeah, about a month ago. Technician 4 was asking me about it.
>
> **Tech 7:** Oh I didn't realize he had that problem too. So what can you tell me about it?

In this particular interchange, we learn that Technician 1 has been consulted about this issue in the past. Not only is she able to share her own knowledge of this problem with the more junior technician, but she is also able to share the information she learned from Technician 4 by helping him resolve this issue. Such practices were quite common before the implementation of the ITSM into the work of NETS technicians.

Social Pressures Produce Discrepant Events

In this section, I discuss the social pressures that produced the discrepant events that marked the four phases of technology use and advice seeking in the NETS organization. The first discrepant event was the initial introduction of the ITSM into the routine work of the

technicians. This event was initiated by the IT manager, but agreed to by all the NETS technicians. This event marked a breakpoint between Phases 0 and 1, or work before the implementation of the ITSM and the first phase of ITSM use. The second discrepant event occurred when one of the technicians began to perceive that she was wasting an inordinate amount of time working on a problem that another technician had already solved. She aired her grievances at a staff meeting, and the NETS technicians decided to take collective action. This discrepant event marked a breakpoint between Phases 1 and 2. The third and final discrepant event occurred when one of the most senior technicians grew upset that her colleagues did not document their solutions to resolved users issues. In response, technicians collectively agreed to add documentation into the ITSM, marking a breakpoint between Phases 2 and 3 and signaling the final phase of ITSM use.

Discrepant Event 1: *Introduction of ITSM.* Although patterns of interaction among NETS technicians began to change after the departmental reorganization and increased consultation of more senior colleagues led to faster resolution of user issues, the reorganization had still not brought about the primary change the IT manager had hoped for: that each technician would begin to respond to user issues across all the administrative divisions, not just in the division in which he/she had formerly worked. In a second effort to effect such a change, the IT manager called a special meeting with the NETS organization during the last week of January 2003. In lieu of that week's normally scheduled staff meeting, the IT manager asked to meet with NETS to discuss the implementation of the ITSM. Another organization in the IT department—Media Services—had been using the ITSM for about four months to track equipment requests (e.g., LCD projectors) from the various administrative divisions, and the tool had proven successful. Most of the NETS technicians were familiar with the tool, which was nothing more than a basic help-desk queuing application for tracking customer calls.[5] The tool allowed technicians to create "tickets" for new requests for help from users and to track the progress any technicians made to bring the ticket to a close. The ITSM stored information entered into it on a server that was accessible by each NETS technician's personal computer. Thus, each technician could see the information entered into the system by any other technician. The IT manager acquired additional licenses for the ITSM software so that NETS technicians could use it to track and manage help-desk requests from users across the seven administrative divisions. Technicians agreed that the tool would be useful for managing workflow. Because they all had seen this particular tool used by the Media Services organization, they also thought they could easily incorporate it into their work. In fact, technicians indicated that they had wanted for some time to use a tool like the ITSM to help them track their own tickets. Only one technician voiced concern about the adoption of the new technology. He said that it seemed to be a waste of money, given that he already had an established set of practices for tracking user calls. After the IT manager explained that the cost of additional licenses was nominal, this technician agreed, along with the rest, to use the tool. The implementation of the ITSM signaled the start of the first phase of technology use.

Discrepant Event 2: *Perception of Wasted Time.* During the first week of March, Technician 5 raised an issue in NETS' weekly staff meeting. She told the group that she had spent the balance of two days the previous week trying to isolate the cause of an error message on the Human Resources server that read "server object error ASP." After troubleshooting, she discovered that there was an extension installed that was leaking memory. Technician 5 recounted that after closing the ticket in the ITSM she decided to use the tool's search function to see if anyone else had dealt with an error like this in the past. Much to her surprise she discovered that Technician 3 had resolved a similar issue on the server in the Contracts division the month before. Technician 5 was enraged because she would not have wasted so much time on this problem if she had consulted Technician 3 earlier. To prevent future recurrence, Technician 5 recommended to the group that when initiating a ticket everyone should search the archived tickets to see if another technician had dealt with a similar problem in the past. If another technician had resolved a comparable issue that technician should be assigned to the new problem so it could be expediently resolved. After some discussion, NETS members agreed that when they received requests for help from their former divisions they would begin to assign those tickets to others if they had experience solving an equivalent problem. This decision to use the technology for assignment purposes marked the second phase of ITSM use.

Discrepant Event 3: *Lack of Documentation.* At a staff meeting during the first week of April 2003, Technician 1 raised a concern that she had addressed at several previous meetings: that technicians were not documenting their solutions to problems in a centralized database. Technician 1 had a reputation for being a "documentation queen." Throughout the course of this study I heard her raise this issue several times at various staff meetings, always urging colleagues to begin writing project resolution outlines (PROs) and posting them on shared folders on the server. At this meeting, Technician 4 suggested that rather than creating separate PROs, which technicians rarely did anyway, they could try adding a minimal amount of documentation into the "notes" field in the ITSM. After some discussion, NETS agreed that this would be a wise course of action if for

no other reason than as one technician commented "so she would get off our backs about documentation." This decision to add documentation about the processes one took to resolve a user problem into the ITSM marked the third phase of technology use.

Discrepant Events Lead to New Technology Appropriations

In response to each of these discrepant events, technicians made collective decisions about how to change their work to alleviate growing social pressures. In this section, I discuss the nature of the appropriations technicians made of the ITSM in response to each of the discrepant events. Technicians appropriated the ITSM in three different ways during the course of this study. In Phase 1, the first period of ITSM use after the departmental reorganization, technicians used the ITSM's material feature to store basic information about project initiation and resolution in the tool. In Phase 2, technicians responded to Technician 5's perceived frustration at her duplication of efforts and began to use the ITSM to assign projects to technicians who had documented a similar issue in the past. Finally, in Phase 3 technicians responded to Technician 1's request to document their responses to a user ticket by using an empty field in the ITSM to provide detailed information on the steps they took to solve the user's problem.

Appropriation 1: *ITSM as Incident-Tracking Tool.* Technicians normally received requests for help from users either via phone or e-mail. Because each technician had previously served as the single-point contact for users in one administrative division, they were accustomed to receiving requests for assistance from a relatively small user base. Users were quite informal in soliciting help from their assigned technician. After the IT department was reorganized into functional organizations, NETS technicians continued to receive requests for technical assistance by direct contact from users. To respond to these requests, technicians typically scheduled a time to meet the user at his or her desk and entered the appointment time into their calendar. Each technician had his/her own practice for documenting the solutions to problems. Some felt the issues they encountered were so basic as not to merit documentation. For others, the processes used to solve a user issue were documented in a text file and stored on his or her hard drive. Others saved the webpages they consulted in their Web browser favorites in case they ran across the problem again.

For technicians, the most obvious affordance of the newly implemented ITSM was that it provided an easy and convenient way for everyone to similarly record evidence of their work. The basic requirement for creating a ticket consisted of entering into the fields at least five pieces of information: (1) the user's contact information, (2) the date and time the user requested help, (3) a summary of the problem, (4) the date and time the technician responded to the request, and (5) the date and time the problem was resolved. Initially, technicians responded favorably to this:

> I think that this is a good way of keeping track of tickets. It really doesn't take any time and I have a quick reference guide if I ever need to go back and see what the problem was or see how long it took to fix it.

Other technicians also commented that the use of the ITSM helped them respond more quickly to user problems. Because they were more reflexive about the time it took to resolve an issue, they were forced to enter the time into the tool. Thus, the basic pattern of appropriation of the ITSM during Phase 1 was that technicians recorded the initiation and resolution of a ticket. Technicians followed the procedure recommended by the software providers for creating and tracking a ticket. Moreover, they consistently used the ITSM to track issues as their manager requested.

Appropriation 2: *ITSM as Project Assignment Tool.* Until this important staff meeting, NETS technicians had rarely resolved a user issue outside of the divisions in which they had formerly worked. For most technicians, assigning jobs to other technicians was emotionally difficult because it signaled that the ownership they felt over their group of users was diminishing. By responding to Technician 5's frustration at her perceived duplication of effort, technicians decided that they should assign jobs based on one's experience with problems, not on their familiarity with a division. This was a difficult transition for Technicians 2 and 7. Initially, they did not assign jobs based on past experience, but after two weeks, each had been assigned a job (by another technician) in a division in which they had not worked before. Thus, they did not have sufficient time to meet all the needs of their former division and, because of these time pressures, were forced to begin assigning jobs to other technicians.

For most technicians, however, this transition was relatively smooth. By the second day after NETS members made the decision to use the ITSM for assigning jobs based on past experience, I had already observed technicians making assignments to colleagues three times. In one example, Technician 6 received a request for help on an error in a user's time card software. As he read the e-mail asking for help, he turned to me and said:

> You know, I don't really know a whole lot about this new time card software. Technician 1 was the one who championed it. I noticed a week or so ago that she had several tickets out to fix some of the bugs in the latest version. I guess I'll assign this job to her.

Later that day Technician 6 stopped by Technician 1's desk to tell her that he assigned her this job.

> **Tech 6:** I got a help desk request for some bug in the time card.

Tech 1: Oh yeah?

Tech 6: Yeah, I assigned it to you because I saw that you've worked on them before

Tech 1: (Surprised) Oh really?

Tech 6: Yeah.

Tech 1: You can have it if you want.

Tech 6: No that's fine I'm sure you've got more experience

Tech 1: Ok, I guess I'll take it then.

Such an appropriation of the ITSM marked a departure from how the technology was used in Phase 1. Instead of engaging the technology as a simple incident-tracking tool, technicians began to construct a new functionality for the ITSM—a project assignment tool. Making this new appropriation of the IT did not require altering any of the technology's material properties. The only action required was to use the same technology in a new way. In this case, appropriating the ITSM as a project assignment tool allowed them to support the collective decision they made to share work so as to reduce the time required to solve a problem with which a technician was unfamiliar.

Appropriation 3: *ITSM as Documentation Tool.* Within each ticket window were several fields in which technicians could enter information. The final field at the bottom of the window was marked simply "notes," and up to this point I never observed a NETS technician add any text into this field. In response to the decision made during the staff meeting to add documentation into one of the empty fields in the ITSM, technicians began to add a short paragraph (3–4 sentences on average) about the steps they took to solve a user problem into the "comments" field before they officially closed a ticket. Over the course of two weeks the form of this documentation transformed from paragraphs into short bulleted lists as technicians began to feel they were spending too much time on documentation. As an example of one list, Technician 3 recounted in a series of four bulleted points the steps she took to solve a problem where the MS Word application would not open:

—Tried to open app from multiple locations. Did not work.

—Uninstalled and reinstalled software. Did not work.

—Consulted MS help and saw recommendation to reinstall OS—seemed excessive.

—Renamed NORMAL template in case of possible corruption—Problem solved.

In this documentation of the process he used to solve the user issue, Technician 3 first detailed the methods she undertook to troubleshoot the problem. She then indicated a possible solution that another technician might try if attempting to fix a similar problem. Finally, she described the procedure that eventually solved the problem.

Although technicians began to add documentation into the tool, many did not see an immediate benefit to this. Instead, most complained to each other that adding an extra step to the execution of a ticket seemed like a waste of time. However, Technician 1 initially took it upon herself to encourage her colleagues to keep up this practice by weaving discussion of the tool into everyday conversation. As several technicians continued to ignore her encouragement, she escalated her tactics for compliance by scheduling individual meetings with her nonconforming coworkers. Because Technician 1 was the NETS lead technician, she had the authority to require technicians to document their practices in the ITSM. The three technicians who were slower to begin this practice did not take to it right away, even after their individual meetings with Technician 1. Instead, like the structural pressures encountered in the previous phase by those who did not initially use the ITSM to assign jobs based on past experience, the fact that other technicians added documentation into the tool and then frequently questioned those who did not as to why not eventually forced the three dissenting technicians to change their practices. After several weeks, nearly all technicians began to see some advantage in the new practice:

> I realize now it takes a lot longer to close a ticket than it did before. Instead of just putting the time and date on there now I have to write up what I did to fix the problem. It's sort of a pain to do, but it's helpful to read what other people have done to fix problems. You learn more by seeing how other people work in the trenches.

By appropriating the ITSM as a tool for documentation, technicians began to learn from one another by familiarizing themselves with the procedures others took to fix complex problems.

Technology Appropriations Mobilize Information Through Advice Networks

The foregoing analyses reveal that within each phase of structuring, building social pressures in the NETS organization led to certain discrepant events that allowed them to purposefully change their use of the ITSM. To determine if the way NETS technicians actually appropriated the features of the ITSM impacted their patterns of advice seeking, I used the QAP, which calculates Pearson's correlation coefficient between corresponding cells of two data matrices. The procedure repeats these calculations multiple times by holding the structure of one matrix constant and randomly permuting the rows and columns of the other, thus testing if the association between the two networks is statistically significant. To execute the QAP analysis, the adjacency matrices in Figure 2(a) were compared with each other and with the ideal network presented in Figure 2(b). The results, summarized in Table 2, show how these networks differed from one another over time. First, the QAP analysis shows that of all the networks, only those in Phases

Table 2 QAP Correlations of Advice Networks Across Phases of Technology Use

	Ideal	Phase 0	Phase 1	Phase 2	Phase 3
Ideal	1				
Phase 0	0.45**	1			
Phase 1	0.46**	0.33*	1		
Phase 2	−0.14	−0.14	0.09	1	
Phase 3	−0.33**	−0.50**	−0.26	0.12	1

*$p < 0.05$, **$p < 0.01$.

0 and 1 were significantly correlated with the ideal network. In other words, before the ITSM was implemented, and immediately following the implementation, NETS technicians sought advice in ways that corresponded to their formal job descriptions—they either asked for help from their superiors or from their peers, but seldom from those lower in the hierarchy. In addition to a high degree of correlation with the institutional ideal, advice networks in Phases 0 and 1 were also significantly correlated. In Phase 1, technicians appropriated the ITSM as a tool to track user incidents and only made use of its features for initiating and closing tickets. Because they appropriated the tool in this way, technicians were able to replicate their old work practices and continue to maintain small levels of interaction with colleagues.

In Phase 1, technicians continued to receive requests for help directly from the users with whom they used to work, and each technician was responsible for creating his or her own tickets. As a consequence, even though the database of tickets was shared via a central server, NETS technicians rarely looked at the tickets created by their colleagues. Because technicians did not consistently review the tickets created by NETS members, the fact that one individual might tarry in documenting his or her work was of little consequence to others.

That NETS technicians did not review the ticket information entered by others is not surprising given that the only information routinely recorded was related to the initiation and resolution of the ticket. This information was not useful in helping technicians to solve their own problems. Thus, technicians continued to consult more senior colleagues when they ran into problems that could not be immediately resolved. In one instance, when Technician 8 was having difficulty uncovering the reason that several of the keys on one of her user's notebook were not working, she took the machine to Technician 2's office for help. Technician 2 spent 20 minutes looking at the keyboard with her and concluded that because the 2, W, S, and X keys were all out that the problem must be with the keyboard. On the way back to her office, Technician 8 stopped by Technician 7's desk to chat. Technician 7 asked her what she was doing with the laptop, and Technician 8 explained the problem and recounted Technician 2's diagnosis.

> **Tech 7:** No, I don't think it's a keyboard issue. I closed a ticket like this on a notebook a while back and it's a documented problem with the motherboard; that's why the whole band of keys went out.
>
> **Tech 8:** Oh, well that would make sense. Should I look at your ticket?
>
> **Tech 7:** There's no point. It doesn't really say anything about it there, just that I recommended that the user just get a new machine.

After returning to her office, Technician 8 commented about her encounter with Technician 7.

> I'm glad I ran into Technician 7. I didn't realize she had any experience with hardware issues. I wonder if that's something she just figured out from calling Dell or if she's dealt with more hardware problems like this before. I just figured Technician 2 would know that kind of stuff because he's been doing this so long.

Recording the initiation and resolution information for a ticket satisfied the requirement that NETS members use the ITSM. By entering a minimal amount of information, however, technicians created a database that was only of use to the individual who documented a ticket. Thus, even though Technician 7 had resolved an issue similar to the one that Technician 8 now faced, that information was only available to her through interpersonal consultation. The ways in which technicians appropriated the ITSM conferred no informational advantage to one's colleagues. As a consequence, NETS technicians were not aware of who had expertise in which technical areas. When it came time to seek advice they followed the organizationally endorsed path and asked for help from more senior technicians.

In Phase 2, technicians did not seek advice up the hierarchy, but began asking for help from anyone whom they knew had worked on a related problem in the past. This pattern of advice seeking corresponds directly to how they appropriated the ITSM. By looking at old ticket entries, technicians developed a sense for who had experience working on what problems. When a new problem arose that was similar to one a technician had resolved in the past, he or she was assigned to that problem. This new practice of job assignment prompted technicians to seek advice based not on one's position in the organization, but based on the jobs they knew he or she had successfully completed.

Throughout Phase 2, technicians continued to appropriate the features of the ITSM so as to allow them to view the types of problems their colleagues had worked on in the past and to assign new tickets based on these emerging areas of expertise. As a result of these appropriations, the ways in which the technicians interacted with users and with each other began to change. Technicians now began to respond to user requests for help across a number of divisions. Although this was a new experience for technicians who had grown accustomed

to dealing with a limited user population, users also had to adjust to receiving help from a technician with whom they were not familiar. When Technician 4 was assigned a ticket to fix a printer issue in a division in which he had not worked before, the first meeting between the technician and the user required both parties to renegotiate the user/technician relationship.

> **Tech 4:** Hi I'm Technician 4. I'm here about your printer problem.
>
> **User:** You're not the guy who normally comes.
>
> **Tech 4:** No, we've reorganized a bit.
>
> **User:** Oh, Ok. I've just never seen anybody else come by.
>
> **Tech 4:** Yeah well I've worked on some printer issues like this in the past.
>
> **User:** Then you should be able to take care of this right away (laughs).

The decision to make deliberate appropriations of the ITSM to assign jobs based on past experience changed the interaction patterns that technicians had with users.

While such changes in the realm of technician/user relations were certainly an anticipated result of shifting appropriations, an unanticipated result was that NETS technicians would also begin to interact with each other in new ways. In Phase 1, technicians deliberately sought assistance on technical issues from colleagues with longer tenures in the organization and normally only asked for assistance on technical issues from those with equal or shorter tenures through fortuitous interactions (i.e., running into each other in the hall). But as they began to use the ITSM to assign jobs based on past experience, they became aware of the types of issues about which their colleagues had the knowledge and skill to resolve. The act of scanning past records required technicians to become familiar with the types of jobs in which other NETS members had developed skills. Through this practice, technicians began to develop a knowledge base about, as one technician put it, "who knows what about what":

> You know I'm actually impressed by the skills people have here. It's not something I was aware of before. When you actually look to see who's been doing various things you see who knows what about what and it's like everyone has a specialty. The nice thing is that just means you know exactly who to ask if you ever have some issue you haven't faced before. You just look at the old tickets in the ITSM and you know exactly who to go to for help. I basically used to just talk to Technician 2, but now I talk to a lot more people.

Technicians now had a larger field of reference from which to draw when dealing with complex user issues, and they began to ask for help on such issues based on who had worked on a similar problem in the past. Although this information had been available since the implementation of the ITSM, technicians did not access it and therefore did not use it until they changed the way they appropriated the tool.

The advice network in Phase 3 is negatively correlated with the ideal network. This suggests that in the final phase, when technicians added documentation into the tool, they sought help down the hierarchy instead of in accordance with the formal chain of command. In this phase, the new appropriation of the ITSM (using it as a documentation tool) merged with the way the tool was used in the previous phase (using the tool to assign jobs based on past experience) to change the way technicians worked. Technicians began assigning jobs based not just on the types of tickets another technician had closed in the past, but on that technician's expertise as detailed in their documentation of issues. The following interchange between Technicians 3 and 4 illustrates this emerging practice.

> **Tech 4:** What are you doing?
>
> **Tech 3:** Just reading some of the documentation on one of these old tickets.
>
> **Tech 4:** Something you wrote?
>
> **Tech 3:** No, something Technician 8 wrote actually. I think for one of my tickets the problem's the same and she says here she didn't need to do a clean install. I'll have to ask her about it. In fact I think it might be better just to assign this to her since she seems to have so detailed knowledge in this area.

Not only did the ways in which technicians assigned problems change as a result of this new appropriation of the ITSM, but their own consultation patterns began to change as well. Whereas in Phase 2 a technician knew that one of his/her coworkers was capable of solving a technical issue because he or she had dealt with it before, in the current phase the addition of documentation detailed one's level of expertise about a particular issue. As Technician 2 observed after reviewing the documentation in a ticket submitted by Technician 8:

> I didn't realize she knew so much about network security but I saw she wrote sort of a mini treatise on it in the ITSM for one her tickets. That was pretty impressive. I've been working here for over 20 years and I certainly don't know that much about it. I think this is a real good thing for this team. Boy, maybe I need to learn some new skills or all these new kids are gonna start running circles around me.

A consequence of "learning the things different people are experts about," as one technician put it, was that NETS members began seeking advice from those whom they felt had a certain amount of expertise on a given issue:

> **Tech 3:** I saw in the documentation of this one ticket that a user was having some problems working in Excel and you wrote a macro for him.
>
> **Tech 7:** Yeah, it was pretty simple just to automate some of his tabulations.

Tech 3: You have some expertise in this area, huh? Is that difficult to do?

Tech 7: No it's actually really simple.

Tech 3: Could you help me do that? I'd like to do something like this in the future.

Appropriating the ITSM for documentation provided technicians with information that allowed them to view the areas in which others had amassed expertise and prompted them to seek advice in line with those who appeared to know the most about the issue at hand. Overall, the QAP analysis shows that the ways in which the ITSM was appropriated in each phase led to significant changes in patterns of advice seeking among technicians.

Although the QAP analysis shows differences and similarities in the structures of these networks over time, it does not help to explain the contours of these changes. To more accurately describe how advice-seeking behaviors changed in Phases 2 and 3, centralization scores were obtained for technicians. Technicians with a high degree of centrality are key players in the advice network—they are often asked for help by multiple technicians. If the observed networks conformed to the institutionally legitimized ideal, then the most central actors would be the Class 3 technicians because they are the most senior. To test whether this was the case, I calculated degree centrality scores for all eight technicians. Degree centrality measures how active a particular actor is in the sense that they have the most ties to other actors. Wasserman and Faust (1994) suggest that degree centrality is often linked to the status of an actor because it locates an individual at the center of action. Gould (2002) notes that a measure of status conferral can be obtained by looking at in-degree ties, or how many times an individual is sought for advice rather than how many times they ask for it. The results in Figure 3(a) show the degree centrality for in-ties for all eight technicians. The measures are normalized to account for slightly different rates of advice-seeking activity across the four phases.

The findings indicate that the most central actors in the advice network for Phases 0 and 1 were Technicians 1 and 2, both of whom were Class 3 technicians. Conversely, the least central actors in these two phases were Technicians 6, 7, and 8, all of whom were Class 1 technicians. Thus, both before and after the implementation of the ITSM, advice-seeking patterns followed the institutionally legitimated ideal. In Phase 2, all technicians received relatively similar centrality scores, meaning that everyone was asked for help nearly the same number of times. When technicians began using the ITSM to assign jobs to each other, they learned who had experience in what particular area, and then started to ask for help based on this knowledge rather than asking blindly up the hierarchy. In this phase, advice seeking was not tied to one's formal position. Instead, the technician who was known to have successfully solved a user issue in the past was sought for advice on similar new user issues. Phase 3, however, marks a near complete inversion of the hierarchy. The technicians sought for help the most often are Class 1 technicians, and Technician 8 in particular, the most junior member of the organization. This finding explains the negative correlation identified by the QAP analysis. As technicians added documentation into the tool in Phase 3, others began to see that the junior people were proficient at difficult tasks. Because they had recently completed their schooling, junior members were more up to date on solutions for new and complex problems. Technicians at all levels began to seek help down the hierarchy, violating the ideal structure of advice seeking. The scatter plot in Figure 3(b) clearly shows this pattern. Technicians who were initially the most central in the advice networks became the most peripheral by Phase 3, and those who were peripheral before implementation of the ITSM became more central. Thus, the status hierarchy inverted due to the ways in which the features of the ITSM were appropriated.

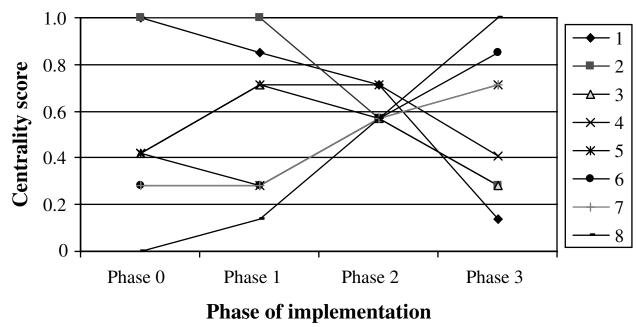
Network centralization scores indicate that even though advice-seeking behaviors inverted across the four phases, the network remained relatively centralized. Only during Phase 2, when individuals began assigning problems based on past experience, did the network become

Figure 3 Centralization of NETS Members in Advice Networks

(a) Centrality Scores (Normalized Degree) for Individual Technicians and Technician Roles

Technician	Phase 0	Phase 1	Phase 2	Phase 3
1	1	0.85	0.71	0.14
2	1	1	0.57	0.28
3	0.42	0.71	0.57	0.28
4	0.42	0.71	0.71	0.41
5	0.42	0.28	0.57	0.71
6	0.28	0.28	0.57	0.85
7	0.28	0.28	0.57	0.71
8	0	0.14	0.57	1
Class 3 technicians	1	0.92	0.64	0.21
Class 2 technicians	0.42	0.56	0.61	0.32
Class 1 technicians	0.19	0.23	0.57	0.85
Overall network centralization (%)	59	53	10	51

(b) Scatter Plot of Network Centrality for Individual Technicians



decentralized. Students of technology and organization have long argued that the implementation of a new technical system will cause an organization to become centralized (Leavitt and Whistler 1958). These findings show that the degree of centralization was directly tied to how technicians appropriated the ITSM rather than to any inherent properties in the technology. Only when technicians were either unaware of each other's skills or completely knowledgeable of them did the network tend toward centralization. As Van Maanen and Barley (1984, p. 326) observe, members of occupational communities attain centrality by acquiring reputations for expertise. These data suggest that the organization was far more centralized when expertise (whether defined by tenure or documented problem-solving ability) was the rubric on which advice seeking was done. If researchers only look cross-sectionally at an organization's social structure, they may miss how the shifting steps of the social construction process can promote centralization in one phase and discourage it in another.

Although the analysis of centrality shows status changes for individual technicians, it does not demonstrate broader patterns of change over time. To investigate these changes further, role relations among technicians were blockmodeled and submitted to CONCOR,[6] an algorithm that clusters nodes of a network into structurally equivalent groups. CONCOR correlates a set of stacked adjacency matrices and iterates the resulting correlation matrix until the set of actors are reduced to structurally equivalent positions. CONCOR then identifies groups with sets of ties that are maximally similar to each other and maximally different from those in other groups. Because I was interested in how the observed groupings related to the formal structure of the organization (i.e., their official positions as Class 1, 2, or 3 technicians), I imposed the institutionally legitimate (ideal) network on the blockmodel to see if advice-seeking behaviors followed the expected pattern rather than letting CONCOR determine the blocks on its own.

By imposing the ideal network on the blockmodels generated from the observed advice networks, I constructed a density matrix for each phase. A density matrix has positions rather than individual actors as its rows and columns, and its values represent the proportion of ties that are present from actors in the row positions to the actors in column positions. Because network data rarely contain perfectly structurally equivalent actors, I followed the α density rule, whereby a tie is specified as present (a oneblock) between two positions if the density of ties from actors in one position to actors in another is greater than or equal to the density matrix as a whole, and absent (a zeroblock) if it is below this threshold to convert the density matrices into image matrices (Wasserman and Faust 1994). The resulting image matrices for the block models of the four phases are displayed in Figure 4(a).

Figure 4 Reduced Blockmodel of Role Relations among NETS Technicians

(a) Image matrix

Phase 0

1	1	0
1	1	0
1	0	0

Phase 1

1	0	0
1	0	0
1	1	0

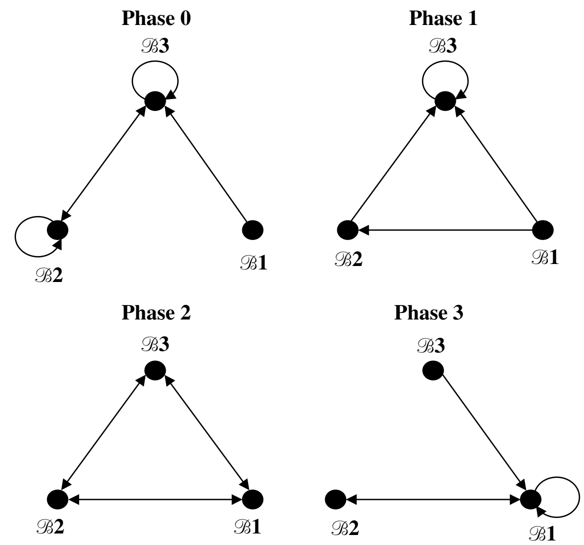
Phase 2

0	1	1
1	0	1
1	1	0

Phase 3

0	0	1
0	0	1
0	1	1

(b) Reduced graph



Notes. ℬ3 = Class 3 technicians, ℬ2 = Class 2 technicians, ℬ1 = Class 1 technicians.

To visually interpret these blockmodels, I converted the image matrices into reduced graphs (Figure 4b). A reduced graph illustrates positions as nodes, and ties between positions in the image matrix as arcs. The directionality of the arrows demonstrates which blocks (ℬ) sought advice from which blocks in each phase. ℬ3 corresponds to those who occupied the position of Class 3 technician, ℬ2 for Class 2 technician, and ℬ1 for Class 1 technician. Comparing these reduced graphs across the four phases shows a dramatic shift in advice-seeking behaviors. In Phases 0 and 1, technicians sought advice from colleagues with positions higher up the formal organizational hierarchy or within their own position. In Phase 2, there is a balanced distribution of advice-seeking behaviors with members of each position asking members of all other positions for help. Finally, in Phase 3 we see a near-complete inversion of the advice-seeking structure, with Class 2 and 3 technicians asking for help most often from Class 1 technicians. These findings show that changes in advice-seeking behavior were not idiosyncratic to individual technicians, but occurred uniformly across all individuals in similar structural positions.

Discussion and Implications

The findings of this study show how the informational capabilities of a newly implemented IT can, over time, lead to changes in the social structure of an organization. Rather than simply documenting that changes took place, these findings begin to explain why the organization changed in the ways that it did. The process of *activation* is central to these changes. The primary definition of the word activation suggests that something static is made dynamic.[7] Information alone, it can be argued, is a static phenomenon. It is only through its engagement in a social context that it becomes dynamic, acquiring meaning and thus the ability to transform organizations (Brown and Duguid 2000). Data from the NETS organization suggest that the newly implemented ITSM did not bring about changes in the social structure of the NETS organization until certain appropriations of the technology's features activated the information stored in the tool into resources technicians used to seek advice from each other. In other words, building social pressure in the NETS organization produced discrepant events that provided technicians with the opportunity to make new choices about how to use the ITSM to respond to user requests for help. These changes then led to and were reinforced by the ways technicians initially appropriated the features of the newly implemented ITSM. As they made the collective decision to change the way they worked and to use the technology to do it, this disjuncture from normal practice created the opportunity for technicians to view the ITSM in a new way. As a consequence, certain features of the ITSM that were of no apparent use to technicians as they conducted their old work practices now afforded them the possibility of working in new ways. Appropriating the same IT in three different ways gave technicians the opportunity to learn about the competencies, skills, and expertise of their coworkers. With this new information, technicians were able to make informed decisions about from whom to seek advice on important technical matters. As constitutive features of the organization's social system, these new advice-seeking practices brought about changes in the social structure of the NETS organization. Thus, through three consecutive phases of variations in the ways technicians used the ITSM and sought advice about technical matters, the social structure of NETS was dramatically transformed from its initial hierarchically rigid form.

A less-used definition suggests that to activate means to organize. The data presented herein point to the importance of viewing activation as a process of organizing. New ITs provide only potential for new ways of organizing. To bring about change, the new informational capabilities enabled by a technology must be activated into resources that actors can use to organize their work. These findings suggest that the informational capabilities of an IT are activated and thus have implications for the organization of work as discrepant events produce new technology appropriations that allow technology users to mobilize the information enabled by it in new ways as they interact with one another. In the context of a new IT implementation, the activation of the artifact's informational capabilities can be seen as an important precondition for organizational change. This is evidenced perhaps most strongly by the lack of change that occurred in the NETS organization between Phases 0 and 1. In Phase 1, technicians appropriated the ITSM as a tool to store data about project initiation and resolution—basic data such as when they initiated and closed a ticket. Appropriating the ITSM in this way did not provide new informational capabilities to technicians over their prior practices of using spreadsheets, or even paper and pencil, to record this data as they did in Phase 0. Although the material features of the ITSM theoretically could provide more informational capabilities, the manner in which those features were appropriated precluded technicians from access to new and different kinds of information. By using the ITSM in this way, technicians had access only to the same type of information that they did before they began to use it. Because technicians did not use the ITSM in Phase 1 in a way that enabled new informational capabilities over their practices in Phase 0, patterns of advice seeking remained the same as prior to the technology's introduction and the social structure of the organization did not change. Once technicians began to appropriate the features of the ITSM in ways that produced new informational capabilities (as in Phases 2 and 3), they were able to use that information to seek advice differently. Thus, the activation of the informational capabilities of the new technology led to organizational change.

These findings have a number of implications for theory on technology-induced organizational change. First, the data suggest that social pressures are needed to induce change. Many studies of new IT implications document how management often tries to reduce or eliminate social pressures surrounding a new technology to increase a group's acceptance of it (Markus et al. 2000, Orlikowski et al. 1995, Robey and Sahay 1996). These data, however, suggest that allowing social pressure around a new technology to build might in fact be a healthy way to foster organizational changes. Building social pressure led to new discrepant events, which were necessary to catalyze changes in the NETS organization. As Majchrzak and colleagues (2000) argued, allowing discrepant events to manifest into organizational changes requires that management and workers alike recognize such events as discrepant, and then decide for themselves what next steps are best to take (i.e., how to best appropriate the features of new technology). Viewed this way, discrepant events are opportunities during which organizational members can learn how and why to use a new

IT differently and/or in ways they had not considered appropriate before, or had not considered at all.

One question that remains unanswered in this data is how long technology adoption must take to allow social pressures to build. On the NETS team, each cycle of building social pressure → discrepant event → new appropriation took, on average, slightly over one month. After three of these cycles (approximately four months after the ITSM was implemented), the patterns of advice seeking finally stabilized. This finding concurs with Tyre and Orlikowski's (1994) data, which showed that most adaptations of new technologies in three consulting organizations ended between three to four months after their initial implementation. Taken together, these findings suggest that the overall effects of technology-induced organizational change may take several minor adaptations in organizational structure before they finally crystallize. These adaptations may look qualitatively different in various organizations because the social pressures, which lead to discrepant events and to appropriations, are germane to the particular social context in which they occur. However, the overall process of activating the informational capabilities of a technology to induce change may look quite similar to that identified here.

Another important implication for theory concerns the link between the micropractices of IT use and the macrochanges in the social structure of an organization. In the NETS organization, the interactions most affected by the ITSM were those involving advice seeking. As discussed at some length, advice and information are inextricably linked through status conferring gestures. For researchers who study IT-induced organizational change, advice networks may mark one clear way of explaining the contours of organizational change. In this context, as would be the case in most IT organizations, advice seeking among NETS members provided technicians with information that was useful and often necessary to solve customer problems. This relationship between within-group advice seeking and external advice giving was not initially recognized by technicians or the IT manager. Activating the informational capabilities of the ITSM helped to make this recognition salient to all those involved. For the NETS organization, the implementation and subsequent activation of the IT capabilities helped them to realize that to provide enhanced customer service (an external demand), they needed to effectively share information with each other (an internal demand). This suggests that the ways the informational capabilities of a new IT are activated after implementation may help to identify the underlying core practices needed to provide the services the organization is committed to providing.

Thus, the core practice of advice seeking in the NETS organization was imposed neither by technicians themselves nor by management because they did not know it was needed. Instead, the work practice evolved from allowing the technicians to experiment with the technology. This finding resonates with the results of other studies, which suggest that newly implemented ITs do not always fit immediately with the demands of the social context into which they are introduced (Leonard-Barton 1988, Thomas 1994, Walsham 2002). Instead, the data support a social constructivist position on technology-induced organizational change. They suggest that to achieve an optimal alignment between a technology's material features and the demands of the social context in which it is implemented, users must be allowed the freedom to adjust both their own practices of appropriation and patterns of interaction. As occurred on the NETS team, each cycle of adjustment will result in the building of social pressures that lead to a discrepant event that catalyzes the next cycle until users feel comfortable that there is congruence between their interactions in the material (with the technology) and social (with their coworkers) realms. It may then be beneficial for managers to take a less overt stance in enforcing a particular use of a newly implemented technology. Allowing social pressures to build, and changes in technology use to result in alterations in patterns of interaction, may be a necessary step in realizing organizational change.

To uncover how and why these cycles of adjustment take place, the social network methods presented in this study might prove useful. Much research has taught us that a defining trait of an IT is its ability to quickly and reliably generate, store, and share information (Markus 1983, Rice 1987, Walsham 2002). As the affordances of a new technology enable changes in the patterns of information sharing among a group of users, some actors become central to the information, whereas others become more peripheral (Burkhardt and Brass 1990). For example, Majchrzak et al. (2000) found that after the implementation of a collaborative Internet-based IT, the centrality of the leader of a project team formed to design a new rocket began to shift. Barley (1990a) also showed that as the informational capabilities afforded by a new CT scanner gave technologists access to new information, they became more central to information sharing within their radiology departments. In the NETS organization, the information-sharing capabilities afforded by the ITSM initially threw the social status hierarchy, long guarded by the private holding of expertise, into flux. After technicians began to use the ITSM as a job assignment tool, the network became highly decentralized (during Phase 2). It was not until they began to qualify the information added into the tool (through documentation practices) that it became clear to the group that the junior technicians were more technically competent than their senior colleagues at more difficult issues. As a consequence of this information sharing, junior technicians became the most central actors.

Clearly, the ability to access information and leverage it in interaction defines the political relations among groups. The analyses of technicians' use of newly available information aligns with previous studies showing how ITs can help to reformulate role relations precisely because knowledge and expertise are tied directly to information retrieval, generation, and execution (Aydin and Rice 1992, Zabusky 1996). On the NETS team, these interactions evolved throughout the course of this study from hierarchical, to democratic, to meritocratic. Such an evolution makes good sense given that most canned antidotes to hierarchical structures tend to involve the introduction of democratic decision-making practices into an organization (for a review, see Deetz 1992). When the informational capabilities of the ITSM were finally activated in a way that allowed technicians to receive credit for their own skills and contributions, a meritocratic structure resulted. Data indicate that cycles of adjustment ended with this meritocratic structure because, at this point, technicians' use of the ITSM finally allowed them to work in the way that they had always wanted to. As NETS technicians enthusiastically stated, they joined a slower-paced research lab because they wanted to work in an environment where they could work with others, feel as though they were making an important contribution, and were given recognition for their expertise.

The informational capabilities enabled by new ITs should not be given short shrift in organizational research. The outcomes arising in the wake of a newly implemented IT can only be understood by examining the ways in which those informational capabilities are activated in the process of organizing. It is when the material features of an IT are appropriated that the information created, modified, transmitted, and stored by them can lead to organizational change.

Acknowledgments
The author thanks the technicians at SkyLabs for their participation in this study. This manuscript has benefited from many conversations with Steve Barley, Diane Bailey, and Ingrid Erickson, and from careful readings and criticisms by Dan McFarland. Three anonymous reviewers and Senior Editor Ann Majchrzak also offered invaluable advice for improving this manuscript.

Endnotes
[1]The two most senior technicians began their tenure at SkyLabs before the introduction of PCs into the administrative divisions. In the early days, 80-column punch cards were used for large-scale data-processing operations. Technician 2 retained several of the punch cards in the office that he once used and eagerly showed them to individuals who were interested in the history of computing.

[2]Barley (1986) suggests that using such practices themselves to locate breakpoints would risk theoretically propitious partitioning by maximizing the homogeneity and heterogeneity of practices within and between phases.

[3]Although there was no organizational policy requiring a technician to ask only hierarchical superiors' advice on technical issues, it quickly became evident after only a few weeks of observation that this practice was a strong cultural norm. Further, interviews with the IT manager and attendance in departmental staff meetings also revealed that the practice of seeking advice up the hierarchy was strongly endorsed by management.

[4]The eighth technician worked previously on a project team that was assigned to provide technical support for the CEO's office.

[5]The ITSM observed in this study appears to have much in common with the Incident Tracking Support System (ITSS) studied by Orlikowski (1996). Whereas the technicians studied by Orlikowski ran a basic phone-in hotline, NETS technicians responded to user issues by attending to the problem physically on the user's machine. While the organizational response to user incidents differed between these studies, the actual functionality of the technology appears quite similar.

[6]The CONCOR procedures I used can be found in Version 6 of UCINET: (Borgatti et al. 2002).

[7]Here I draw on the first and second definitions of the word "activate" from the 2000 edition of the *American Heritage College Dictionary* published by Houghton Mifflin Company.

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